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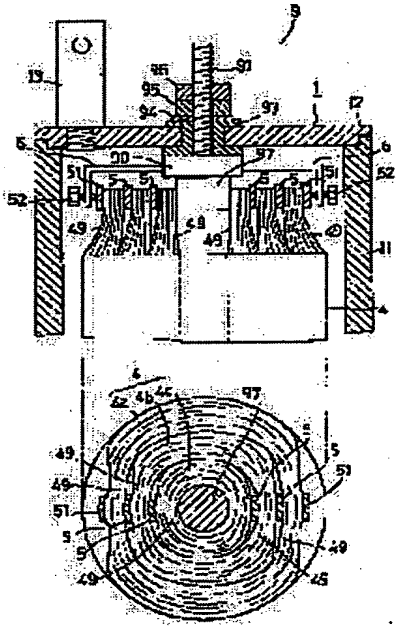
(54) NONAQUEOUS ELECTROLYTE SECONDARY BATTERY

(57)Abstract:
PROBLEM TO BE SOLVED: To provide a nonaqueous electrolyte secondary battery with lower inner resistance than conventional ones and yet having more excellent collecting structure.
SOLUTION: With the nonaqueous electrolyte secondary battery, at an end of a wound electrode body 4 to its axis direction, a non-coated part where active substance is not yet applied is protruded from a core body making up a positive or a negative electrode. The protruded part is engaged to a collecting mechanism, and is divided into a plurality of ring-shaped areas 4a, 4b and 4c. The collecting mechanism is provided with a round-shaft member 97 fitted into an inner peripheral face of the inner-most-periphery ring-shaped area 4c, spacer pieces 5 disposed between adjoining ring-shaped areas, a pressing piece 51 connected to an outer peripheral face of the outer-most-periphery ring-shaped area 4a, and a screw shaft 52 for pressing the pressing piece 51 toward the round-shaft member 97, which, together with the screw shaft 52, is connected with an end of an electrode terminal 91 protruding into inside a battery can 1.



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[Claim(s)]

[Claim 1] The rolling-up electrode object (4) which the separator (42) containing nonaqueous electrolyte was made to intervene between band-like positive electrodes (41) and negative electrodes (43), respectively, and rolled these round inside the cylinder-like cell can (1) at the curled form is contained. In the nonaqueous electrolyte rechargeable battery which can take out the power which a positive electrode (41) and a negative electrode (43) apply an active material to the front face of a band-like axis, respectively, and are constituted, and a rolling-up electrode object (4) generates from the electrode terminal area of a couple to the exterior The electrode terminal area of said couple is constituted by the metal electrode terminal (91) attached by penetrating a cell can (1) on a cell can (1) and the same axle, respectively. In one [at least] edge of the shaft orientations of a rolling-up electrode object (4) The non-coating section by which an active material is not applied to the axis which constitutes a positive electrode (41) or a negative electrode (43) A projection, A current collection device is connected with this lobe, and it is divided into two or more ring-like fields (4a) (4b) (4c) which this lobe rolls round and are located in a line on the medial axis of an electrode object (4), and the same axle by this. The metal cylindrical shaft member which inserts this current collection device in the inner skin of the ring-like field of the most inner circumference (97), 1 or the metal spacer piece of two or more sheets (5) which intervenes, respectively between the ring-like fields which are arranged on one radius line of a cylindrical shaft member (97), and adjoin, The metal press piece which was installed on said one radius line and joined to the peripheral face of the ring-like field of the outermost periphery (51), The nonaqueous electrolyte rechargeable battery characterized by connecting with the edge of the electrode terminal (91) with which it has a metal screw-thread device for pressing a press piece (51) toward the cylindrical shaft section (97), and said cylindrical shaft member (97) and a screw-thread device project in a cell can (1), respectively.

[Claim 2] Said cylindrical shaft member (97) is prepared in the edge of the electrode terminal (91) which projects in a cell can (1) at one. Said screw-thread device The nonaqueous electrolyte rechargeable battery according to claim 1 with which it is constituted with the screw-thread shaft (52) which engages with the point of the arm (6) which protruded on the edge of the electrode terminal (91) which projects in a cell can (1), and this arm (6), and said press piece (51) is attached in the point of this screw-thread shaft (52).

[Claim 3] die length when each ring-like field (4a) (4b) (4c) of said rolling-up electrode object (4) develops those fields -- abbreviation -- the nonaqueous electrolyte rechargeable battery according to claim 1 or 2 divided so that it may become the same.

[Claim 4] A spacer piece (5) and a press piece (51) are a nonaqueous electrolyte rechargeable battery given in any of claim 1 currently formed in the configuration which meets the radii line of a cylindrical shaft member (97) and this alignment, respectively thru/or claim 3 they are.

[Detailed Description of the Invention]

[0001]

[Field of the Invention] The rolling-up electrode object used as a rechargeable battery element is held in the interior of a cell can, and this invention relates to the nonaqueous electrolyte rechargeable battery which can roll round from the electrode terminal area of the couple prepared in the electrode can, and can take out the generating power of an electrode object.

[0002]

[Description of the Prior Art] In recent years, the rechargeable lithium-ion battery with a high energy density attracts attention as a power source of pocket mold electronic equipment, an electric vehicle, etc. For example, as shown in drawing 4 and drawing 5 , the comparatively big cylindrical rechargeable lithium-ion battery of capacity used for an electric vehicle holds a rolling-up electrode object (2) in the interior of the cell can (1) of the shape of a cylinder which carries out welding immobilization of a lid (12) and (12), and becomes the both ends of a barrel (11), and is constituted. A style (9) and (9) are attached. both lids (12) and (12) -- the electrode edge of a positive/negative couple -- a cordless handset -- the power which two or more two poles of a rolling-up electrode object (2), two-electrodes terminal devices (9), and (9) are mutually connected by the electrode tab (3) of a book, respectively, and a rolling-up electrode object (2) generates -- the electrode edge of a couple -- a cordless handset -- it is possible to take out from a style (9) and (9) outside. Moreover, the gas exhaust valve (13) of a pressure closing motion type is attached in each lid (12).

[0003] As shown in drawing 6 , a rolling-up electrode object (2) makes a band-like separator (22) intervene between band-like positive electrodes (21) and negative electrodes (23), respectively, winds these around a curled form and is constituted. A positive electrode (21) applies the positive active material (24) which consists of a lithium multiple oxide to both sides of the band-like axis which consists of aluminium foil, and is constituted, and a negative electrode (23) applies the negative-electrode active material (25) containing a carbon material to both sides of the band-like axis which consists of copper foil, and is constituted. Impregnation of the nonaqueous electrolyte is carried out to the separator (22). The end face section of two or more electrode tabs (3) is joined to a positive electrode (21) and a negative electrode (23) by spot welding etc., respectively, and the point projects from the rolling-up electrode object (2). In addition, the electrode tab (3) joined to the positive electrode (21) is formed from aluminium foil, and the electrode tab (3) joined to the negative electrode (23) is formed from copper foil.

[0004] and it is shown in drawing 5 -- as -- the point (31) of two or more electrode tabs (3) with the same polarity -- one electrode edge -- a cordless handset -- it connects with the style (9). in addition, drawing 5 -- setting -- for convenience -- the point of some electrode tabs -- an electrode edge -- a cordless handset -- the condition of connecting with the style (9) -- being shown -- other electrode tabs -- a point -- an electrode edge -- a cordless handset -- the graphic display in the condition of connecting with the style (9) is omitted.

[0005] an electrode edge -- a cordless handset -- a style (9) is equipped with the electrode terminal (91) attached by penetrating the lid (12) of a cell can (1), and the flange (92) is formed in the end face section of this electrode terminal (91). The breakthrough of a lid (12) is equipped with insulating packing (93), and a lid (12), the electric insulation between conclusion members (91), and seal nature are maintained. While a washer (94) is inserted in from the outside of a lid (12), the 1st nut (95) and the 2nd nut (96) are screwing in an electrode terminal (91). And seal nature is raised by binding the 1st nut (95) tight and compressing insulating packing (93) with the flange (92) and washer (94) of an electrode terminal (91). The point (31) of said electrode tab (3) which are books is being fixed to the flange (92) of an electrode terminal (91) by spot welding or ultrasonic welding.

[0006] By the way, in a rechargeable lithium-ion battery, since the die length of a positive electrode and a negative electrode becomes large with enlargement of a cell, with the current collection structure by the electrode tab like ****, current collection nature is low, dispersion occurs in internal resistance or the problem of discharge capacity falling arises.

[0007] Then, the **** current collection structure shown in drawing 7 is proposed in order to cover the overall length of a positive electrode and a negative electrode and to obtain uniform current collection nature. The positive electrode with which a rolling-up electrode object (4) comes to apply positive active material (44) on the surface of an axis (45) similarly in this current collection structure (41), Although it consists of separators (42) with which impregnation of the nonaqueous electrolyte was carried out to the negative electrode (43) which comes to apply a negative-electrode active material (46) on the surface of an axis (47) Respectively a positive electrode (41) and a negative electrode (43) are shifted crosswise, are piled up on a separator (42), and are rolled round by the curled form. By this, while the edge (48) of the axis (45) of a positive electrode (41) projects to the method of outside [edge / of a separator (42)] at one edge among the both ends of the volume shaft orientations of a rolling-up electrode object (4), in the other-end section, the edge (48) of the axis (47) of a negative electrode (43) projects to the method

of outside [edge / of a separator (42)]. and a disc-like collecting electrode plate (32) carries out resistance welding to the both ends of a rolling-up electrode object (4), respectively -- having -- this collecting electrode plate (32) -- a lead member (33) -- minding -- said electrode edge -- a cordless handset -- it connects with a style (9).

[0008] However, in the nonaqueous electrolyte rechargeable battery which has the current collection structure shown in drawing 7 , since the area of the edge (48) of the axis (45) which constitutes the positive electrode (41) and negative electrode (43) of a rolling-up electrode object (4), and (47), and (48) was small, the touch area between the axis edge and a collecting electrode plate (32) was small, and there was a problem to which the internal resistance of a cell becomes large by this. Moreover, it is required to reduce internal resistance as much as possible, in order to obtain high power, and further, in order to be a manufacturing-cost cutback, the current collection structure excellent in productivity is needed.

[0009] Then, as shown in drawing 8 , the current collection structure which welds this bending section (64) by resistance to the axis edge (48) is proposed in the condition of having rolled round this collecting electrode plate (62) and having pushed against the axis edge (48) of an electrode object (4) using the collecting electrode plate (62) which formed two or more bending sections (64) in the plate-like body (63) (for example, refer to JP,11-31497,A).

[0010] Moreover, it replaces with a disc-like collecting electrode plate, as shown in drawing 9 , the current collection member (65) in which two or more slits (66) were cut is rolled round, and it installs in the edge of an electrode object (4), and in the condition of having made the axis edge (48) insert in the slit (66) of this current collection member (65), a laser beam is irradiated on the front face of a current collection member (65), and the current collection structure of performing laser welding is proposed (for example, refer to JP,10-261441,A).

[0011]

[Problem(s) to be Solved by the Invention] However, in the current collection structure which welds by resistance the collecting electrode plate which formed the bending section like drawing 8 , when the thickness of an axis was very small like a rechargeable lithium-ion battery, not only welding is difficult, but the electric resistance in a weld zone was large, and there was a problem that the current collection engine performance was still low.

[0012] Moreover, the current collection member which has a complicated configuration is not only needed, but with the current collection structure which carries out laser welding of the current collection member in which two or more slits were cut like

drawing 9 to the axis edge, since the welding operation to a current collection member was required, there was a problem inferior to productivity.

[0013] The object of this invention has internal resistance lower than before, and is offering the nonaqueous electrolyte rechargeable battery which has the current collection structure which excelled [**] in productivity.

[0014]

[Means for Solving the Problem] The nonaqueous electrolyte rechargeable battery concerning this invention is rolled round inside a cell can (1), contains an electrode object (4) and is constituted. A rolling-up electrode object (4) makes the separator (42) containing nonaqueous electrolyte intervene between band-like positive electrodes (41) and negative electrodes (43), respectively, and rolls these round to a curled form, and a positive electrode (41) and a negative electrode (43) apply an active material to the front face of a band-like axis, respectively, and are constituted. The power which a rolling-up electrode object (4) generates can be taken out from the electrode terminal area of a couple to the exterior. Here, the electrode terminal area of said couple is constituted by the metal electrode terminal (91) attached by penetrating a cell can (1) on a cell can (1) and the same axle, respectively. moreover, in one [at least] edge of the shaft orientations of a rolling-up electrode object (4) The non-coating section by which an active material is not applied to the axis which constitutes a positive electrode (41) or a negative electrode (43) A projection, A current collection device is connected with this lobe, and it is divided into two or more ring-like fields (4a) (4b) (4c) which this lobe rolls round and are located in a line on the medial axis of an electrode object (4), and the same axle by this. The metal cylindrical shaft member which inserts said current collection device in the inner skin of the ring-like field of the most inner circumference (97), 1 or the metal spacer piece of two or more sheets (5) which intervenes, respectively between the ring-like fields which are arranged on one radius line of a cylindrical shaft member (97), and adjoin, The metal press piece which was installed on said one radius line and joined to the peripheral face of the ring-like field of the outermost periphery (51), It has a metal screw-thread device for pressing a press piece (51) toward the cylindrical shaft section (97), and said cylindrical shaft member (97) and the screw-thread device are connected with the edge of the electrode terminal (91) which projects in a cell can (1), respectively.

[0015] In the rechargeable lithium-ion battery of above-mentioned this invention, a press piece (51) drives toward a cylindrical shaft member (97) by binding a screw-thread device tight. Consequently, the ring-like field of the most inner circumference is strongly compressed by a cylindrical shaft member (97) and the spacer piece (5), and is governed

by the non-coating axis bundle (49) which axis non-coating sides stuck. Moreover, the ring-like field of the outermost periphery is strongly compressed by a press piece (51) and the spacer piece (5), and is governed by the non-coating axis bundle (49) which axis non-coating sides stuck. Furthermore, a middle ring-like field is strongly compressed by the spacer piece (5) of two sheets, and (5), and is governed by the non-coating axis bundle (49) which axis non-coating sides stuck. Thus, since each ****** axis bundle (49) of a rolling-up electrode object (4) and each configuration member of a current collection device, i.e., a cylindrical shaft member, (97), a spacer piece (5), and a press piece (51) are mutually stuck by pressure with a large touch area, the electric resistance in the contact surface becomes very small.

[0016] In addition, a spacer piece (5) gets down from a cylindrical shaft member (97) and a press piece (51) independently, and between a cylindrical shaft member (97) and a press piece (51), freely, since it is movable, it can give the equal compression force to each ****** axis bundle (49). Moreover, by inclusion of a spacer piece (5), the axis non-coating section of a rolling-up electrode object (4) does not produce big deformation locally, consequently can prevent exfoliation of an active material spreading layer.

[0017] The current which a rolling-up electrode object (4) generates is taken out outside through the root which flows from a cylindrical shaft member (97) to an electrode terminal (91), and the root which flows from a press piece (51) and a screw-thread device to an electrode terminal (91), after a current is collected by said current collection device. Here, since the electric resistance between a rolling-up electrode object (4) and a current collection device is small, high output density is obtained. Moreover, since the two above-mentioned current ejection roots are formed, the output in a high current is possible.

[0018] die length when each ring-like field (4a) (4b) (4c) of said rolling-up electrode object (4) specifically develops those fields -- abbreviation -- it is divided so that it may become the same. According to this concrete configuration, according to a current collection device, since current collection is carried out to homogeneity from a rolling-up electrode object (4), the high current collection engine performance is obtained.

[0019] Furthermore, in the concrete configuration, the spacer piece (5) and the press piece (51) are formed in the configuration which meets the radii line of a cylindrical shaft member (97) and this alignment, respectively. By this, the faying surface product between a spacer piece (5) and a spacer piece (5), and a non-coating axis bundle (49) becomes large, and electric resistance becomes small further.

[0020] In addition, each configuration member (a cylindrical shaft member (97), a spacer piece (5), a press piece (51), screw-thread device) of the current collection device

by the side of a positive electrode is producible using aluminum, stainless steel, nickel, etc. Moreover, each configuration member of the current collection device by the side of a negative electrode is producible using copper, stainless steel, nickel, etc. A kind of ingredient chosen from the group which consists of LiCoO2 and LiNiO2 which are a metallic oxide, LiCo1-XNiXO2, LiMn(s) 2O4, and these conjugated compounds as positive active material which constitutes a rolling-up electrode object (4) can be used at least. As a negative-electrode active material, the metallic-oxide ingredient of carbon materials, such as a graphite and corks, a lithium metal, a lithium alloy, LiXFe 2O3, and LiXWO2 grade and conductive polymers, such as polyacethylene, can be used. As an electrolyte, LiPF6, LiClO4, and the LiCF3SO3 grade containing metal ions, such as a lithium ion, are mentioned. moreover, independent [in ethylene carbonate diethyl carbonate, dimethoxymethane, a sulfolane, etc.] to an electrolytic organic solvent -- or it can mix and use. As the electrolytic solution, the solution which dissolved said electrolyte in these solvents at a rate of 0.7 - 1.5M (mol/l) extent is mentioned.

[0021]

[Effect of the Invention] In the nonaqueous electrolyte rechargeable battery concerning this invention, by carrying out press working of sheet metal of the metal plate, the spacer piece (5) and press piece (51) which constitute a current collection device can be produced easily, and can produce a screw-thread device easily using a screw-thread shaft. Moreover, anchoring of a current collection device can be performed only by the bell-and-spigot activity, since welding etc. is unnecessary, the anchoring process is simple and productivity higher than before is realized by this. Since ** can also suppress small the electric resistance between a rolling-up electrode object and a current collection device, current collection effectiveness is improved and output density higher than before is obtained.

[0022]

[Embodiment of the Invention] Hereafter, this invention is concretely explained along with a drawing about the gestalt carried out to the cylindrical rechargeable lithium-ion battery. As shown in drawing 4 and drawing 1 , the cylindrical rechargeable lithium-ion battery concerning this invention holds a rolling-up electrode object (4) in the interior of the cell can (1) of the shape of a cylinder which carries out welding immobilization of a lid (12) and (12), and becomes the both ends of a barrel (11), and is constituted. A style (9) and (9) are attached. both lids (12) and (12) -- the electrode edge of a positive/negative couple -- a cordless handset -- the power which the two poles of a rolling-up electrode object (4), a two-electrodes terminal device (9), and (9) are mutually connected according to the current collection structure mentioned later, respectively,

and a rolling-up electrode object (4) generates -- the electrode edge of a couple -- a cordless handset -- it is possible to take out from a style (9) and (9) outside. Moreover, the gas exhaust valve (13) of a pressure closing motion type is attached in each lid (12).

[0023] As shown in drawing 2 , a rolling-up electrode object (4) makes a band-like separator (42) intervene between band-like positive electrodes (41) and negative electrodes (43), respectively, winds these around a curled form and is constituted. A positive electrode (41) applies the positive active material (44) which consists of a lithium multiple oxide to both sides of the band-like axis (45) which consists of aluminium foil, and is constituted, and a negative electrode (43) applies the negative-electrode active material (46) containing a carbon material to both sides of the band-like axis (47) which consists of copper foil, and is constituted. Impregnation of the nonaqueous electrolyte is carried out to the separator (42). Moreover, the axis non-coating section to which positive active material (44) is not applied is formed in one edge of a positive electrode (41), and the axis non-coating section to which a negative-electrode active material (46) is not applied is formed in the other-end section of a negative electrode (43).

[0024] In production of a rolling-up electrode object (4), respectively a positive electrode (41) and a negative electrode (43) are shifted crosswise, are piled up on a separator (42), and are rolled round by the curled form. By this, while the edge (48) of the axis non-coating section of a positive electrode (41) projects to the method of outside [edge / of a separator (42)] at one edge among the both ends of the volume shaft orientations of a rolling-up electrode object (4), in the other-end section, the edge (48) of the axis non-coating section of a negative electrode (43) projects to the method of outside [edge / of a separator (42)].

[0025] the electrode edge which the current collection device shown in drawing 3 is attached in the edge by the side of the positive electrode of a rolling-up electrode object (4), and a negative electrode, respectively, and this current collection device shows to drawing 1 -- a cordless handset -- it connects with the style (9). an electrode edge -- a cordless handset -- a style (9) is equipped with the electrode terminal (91) attached by penetrating the lid (12) of a cell can (1), and the flange (90) is formed in the end face section of this electrode terminal (91). The breakthrough of a lid (12) is equipped with insulating packing (93), and a lid (12), the electric insulation between conclusion members (91), and seal nature are maintained. While a washer (94) is inserted in from the outside of a lid (12), the 1st nut (95) and the 2nd nut (96) are screwing in an electrode terminal (91). And seal nature is raised by binding the 1st nut (95) tight and compressing insulating packing (93) with the flange (92) and washer (94) of an electrode

terminal (91).

[0026] As shown in the soffit section of an electrode terminal (91) at drawing 3 , the cylinder-like cylindrical shaft member (97) protrudes on the flange (90). Moreover, the arm (6) of a left Uichi pair and (6) protrude on the peripheral face of a flange (90), and vertical Itabe (61) protrudes on the point of each arm (6) downward. And it ****s to each vertical Itabe (61), a shaft (52) screws, the point of this screw-thread shaft (52) is countered at the peripheral face of a cylindrical shaft member (97), and the press piece (51) is attached. Furthermore, between both the press piece (51) and the cylindrical shaft member (97), the spacer piece (5) of two sheets and (5) are arranged, respectively. Here, the spacer piece (5) and the press piece (51) are formed in the shape of [which meets the radii line of a cylindrical shaft member (97) and this alignment] radii.

[0027] In addition, the cylindrical shaft member (97), the arm (6), the screw-thread shaft (52), press piece (51), and spacer piece (5) by the side of a positive electrode are a product made from aluminum, respectively, and the cylindrical shaft member (97), the arm (6), the screw-thread shaft (52), press piece (51), and spacer piece (5) by the side of a negative electrode are copper, respectively.

[0028] As shown in drawing 1 , the axis non-coating section which projects at each edge of a rolling-up electrode object (4) It is divided into three ring-like fields (4a) (4b) (4c) to which a rolling-up electrode object (4) is radially located in a line. A cylindrical shaft member (97) inserts in the inner skin of the ring-like field (4c) of the most inner circumference, and the press piece (51) of a couple and (51) are joined to the peripheral face of the ring-like field (4a) of the outermost periphery by the angular difference of 180 degrees. Moreover, between the ring-like field (4a) of the outermost periphery, and a middle ring-like field (4b), the spacer piece (5) of two sheets and (5) intervene by the angular difference of 180 degrees at the list, respectively between the ring-like field (4c) of the most inner circumference, and a middle ring-like field (4b). Of this, six non-coating axis bundles (49) - (49) located in a line on the diameter line of a rolling-up electrode object (4) is formed. in addition, die length, i.e., the area of an active material spreading layer, when three ring-like fields (4a) (4b) (4c) of a rolling-up electrode object (4) develop these fields -- abbreviation -- it is divided so that it may become the same.

[0029] In anchoring of the current collection device shown in drawing 3 , while inserting spacer piece [of four sheets] (5) - (5) in the edge of a rolling-up electrode object (4), after making a cylindrical shaft member (97) insert in the central hole of a rolling-up electrode object (4) first, a compound-screw shaft (52) and (52) are bound tight. By this, each press piece (51) drives toward a cylindrical shaft member (97). Consequently, the ring-like field (4c) of the most inner circumference shown in drawing 1 is strongly

compressed by a cylindrical shaft member (97) and the spacer piece (5), and is governed by the non-coating axis bundle (49) which axis non-coating sides stuck. Moreover, the ring-like field (4a) of the outermost periphery is strongly compressed by a press piece (51) and the spacer piece (5), and is governed by the non-coating axis bundle (49) which axis non-coating sides stuck. Furthermore, a middle ring-like field (4b) is strongly compressed by the spacer piece (5) of two sheets, and (5), and is governed by the non-coating axis bundle (49) which axis non-coating sides stuck.

[0030] Thus, each configuration member (97), i.e., the cylindrical shaft member, spacer piece (5), and press piece (51) of a current collection device are stuck to both sides of each ****** axis bundle (49) of a rolling-up electrode object (4) by pressure, and immobilization of a current collection device is performed. In this current collection structure, since a rolling-up electrode object (4) and a current collection device are mutually stuck by pressure with a large touch area, the electric resistance in the contact surface becomes a very small thing.

[0031] In the above-mentioned cylindrical rechargeable lithium-ion battery, the current which a rolling-up electrode object (4) generates flows the root reached to an electrode terminal (91) through a cylindrical shaft member (97), and the root reached to an electrode terminal (91) through a press piece (51), a screw-thread shaft (52), and an arm (6), and is taken out outside. Here, since the electric resistance between a rolling-up electrode object (4) and a current collection device is small, high output density is obtained. Moreover, since the two above-mentioned current ejection roots are formed, the output in a high current is possible. Furthermore, since the spacer piece (5), press piece (51), and arm (6) which constitute a current collection device can be produced easily and anchoring of a current collection device can perform a screw-thread shaft (52) only by the bell and spigot by carrying out press working of sheet metal of the metal plate, productivity higher than before is realized.

[0032]

[Example] The example cell B of a comparison shown in the example cell A shown in drawing 1 as follows and drawing 5 R> 5 was produced, and the engine performance was compared.

[0033] LiNi0.7Co 0.3O2 as production (production of positive electrode) positive active material of the example cell A mixed the hydroxide of a lithium, the hydroxide of nickel, and the hydroxide of cobalt, and obtained them by giving baking of 24 hours in 800-degree C air. this positive active material and the carbon as an electric conduction agent -- the rate of the weight ratio 90:5 -- mixing -- a positive electrode -- the mixture was obtained. Next, the polyvinylidene fluoride which is a binder was dissolved in the

N-methyl-2-pyrrolidone (NMP), and the NMP solution was prepared. and a positive electrode -- the weight ratio of a mixture and polyvinylidene fluoride is set to 95:5 -- as -- a positive electrode -- the mixture and the NMP solution were kneaded and the slurry was prepared. This slurry was applied to both sides of the aluminium foil as a positive-electrode axis with the doctor blade method, the vacuum drying of 2 hours was performed at 150 degrees C, and the positive electrode was obtained. In addition, the width of face from the axis edge formed in the positive-electrode axis the non-coating section which is 20mm.

[0034] (Production of a negative electrode) Airstream was injected and ground in the carbon lump (d002=3.356A;Lc> 1000A), this was sifted, and graphite powder with a mean particle diameter of 18 micrometers was obtained. Next, airstream was injected and ground in the corks lump, this was sifted, and the coke breeze end of 18-micrometer mean particle diameter was obtained. Moreover, the polyvinylidene fluoride which is a binder was dissolved in NMP, and the NMP solution was prepared. And graphite powder, the end of a coke breeze, and a NMP solution were kneaded so that the weight ratio of graphite powder, the end of a coke breeze, and polyvinylidene fluoride might be set to 72:18:10, and the slurry was prepared. This slurry was applied to both sides of the copper foil as a negative-electrode axis with the doctor blade method, the vacuum drying of 2 hours was performed at 150 degrees C, and the negative electrode was obtained. In addition, the width of face from the axis edge formed in the negative-electrode axis the non-coating section which is 20mm.

[0035] (Assembly of a cell) The rolling-up electrode object (4) shown in drawing 2 was produced using the positive electrode and negative electrode which were obtained according to the above process, and the separator which consists of fine porous membrane made from polyethylene of ionic permeability. and the current collection device of this invention shown in the both ends of a rolling-up electrode object (4) at drawing 1 , respectively and an electrode edge -- a cordless handset -- after attaching the electrode terminal (91) which constitutes a style (9), a screw-thread shaft (52) and (52) were bound tight. Next, this rolling-up electrode object (4) was held in the interior of a barrel (11), and welding immobilization of the lid (12) was carried out at each opening of this barrel (11). A nut (95) and (96) were made to screw in an electrode terminal (91) finally, and the example cell A was assembled.

[0036] With the making process of the production positive electrode of the example cell B of a comparison, and a negative electrode, the positive electrode and the negative electrode were produced like the example cell A except having applied the slurry to the axis completely, without preparing the non-coating section.

(Assembly of a cell) As shown in drawing 6 , while welding 15 electrode tabs made from aluminum to the front face of the aluminium foil which constitutes the positive electrode at intervals of 20cm, 15 copper electrode tabs were welded to the front face of the copper foil which constitutes the negative electrode at intervals of 20cm. And the separator which consists of fine porous membrane made from polyethylene of ionic permeability was inserted between the positive electrode and the negative electrode, and winding and a rolling-up electrode object (2) were produced for these to the curled form. In addition, thickness of the electrode tab of a positive electrode and a negative electrode was set to 0.1mm. and it is shown in drawing 5 -- as -- the electrode tab (3) of each electrode -- an electrode edge -- a cordless handset -- it welded to the flange (92) of a style (9), and the example cell B of a comparison was assembled. In addition, active material coverage of each electrode of the example cell A and the example cell B of a comparison was taken as tales doses.

[0037] (Engine-performance comparative experiments) Before holding a rolling-up electrode object in a barrel, when the alternating current impedance in 1kHz was measured about the example cell A and the example cell B of a comparison, the result shown in the following table 1 was obtained. In addition, the positive-electrode and negative-electrode side performed measurement of an alternating current impedance between the axis non-coating sections and the electrode terminals which are located in the outermost periphery of a rolling-up electrode object.

[0038]

[A table 1]

	Impedance of the side of a negative electrode	Impedance of the side of a positive electrode
Example battery A	4.5mΩ	8.5mΩ
Comparative battery B	25.5mΩ	10.8mΩ

[0039] Also in any by the side of a positive electrode and a negative electrode, the impedance of the example cell A is smaller than the impedance of the example cell B of a comparison, and according to the cylindrical rechargeable lithium-ion battery of this invention, it can be said from this that output density higher than the conventional cell can be obtained so that clearly from a table 1.

[Brief Description of the Drawings]

[Drawing 1] It is drawing showing the cross-section configuration and flat-surface configuration of a current collection device which are adopted as the cylindrical rechargeable lithium-ion battery concerning this invention.

[Drawing 2] some rolling-up electrode objects with which this rechargeable battery is

equipped -- it is an expansion perspective view.

[Drawing 3] It is the decomposition perspective view of the current collection device of this invention.

[Drawing 4] It is the perspective view showing the appearance of a cylindrical rechargeable lithium-ion battery.

[Drawing 5] It is a sectional view showing the current collection structure adopted as the conventional cylindrical rechargeable lithium-ion battery.

[Drawing 6] some rolling-up electrode objects with which this rechargeable battery is equipped -- it is an expansion perspective view.

[Drawing 7] it had other conventional current collection structures -- rolling round -- some electrode objects -- it is an expansion perspective view.

[Drawing 8] It is a perspective view showing the conventional current collection structure of further others.

[Drawing 9] It is a perspective view showing the conventional current collection structure of further others.

[Description of Notations]

(1) Cell can

(11) Barrel

(12) Lid

(4) Rolling-up electrode object

(49) Non-coating axis bundle

(9) Electrode terminal device

(97) Cylindrical shaft member

(5) Spacer piece

(51) Press piece

(52) Screw-thread shaft

(6) Arm

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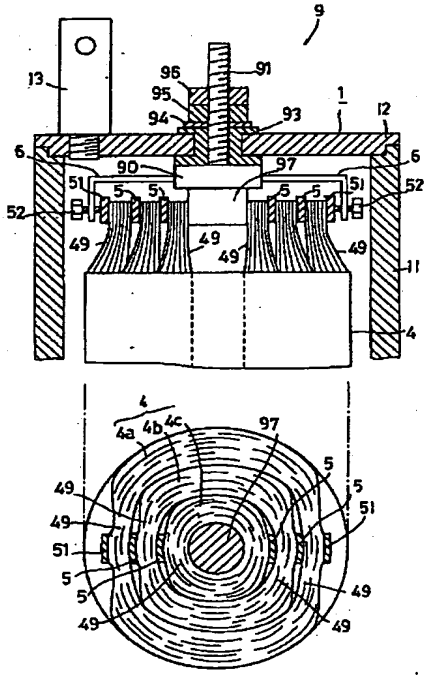
最終頁に続く

(54)【発明の名称】　非水電解液二次電池

(57)【要約】
【課題】　従来よりも内部抵抗が低く、然も生産性に優れた集電構造を有する非水電解液二次電池を提供する。
【解決手段】　本発明に係る非水電解液二次電池においては、巻き取り電極体４の軸方向の端部に、正極或いは負極を構成する芯体に活物質の塗布されていない非塗工部が突出し、該突出部には集電機構が係合しており、これによって該突出部が複数のリング状領域4a、4b、4cに分けられている。該集電機構は、最内周のリング状領域4cの内周面に嵌入する丸軸部材97と、隣接するリング状領域の間にそれぞれ介在するスペーサ片５と、最外周のリング状領域4aの外周面に接合される押圧片51と、押圧片51を丸軸部97に向かって押圧するためのねじ軸52とを具え、丸軸部材97及びねじ軸52が、電池缶１内に突出する電極端子91の端部に連結されている。



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【特許請求の範囲】

【請求項１】　円筒状の電池缶（１）の内部に、それぞれ帯状の正極(41)と負極(43)の間に非水電解液を含むセパレータ(42)を介在させてこれらを渦巻き状に巻き取った巻き取り電極体（４）が収納され、正極(41)及び負極(43)はそれぞれ、帯状芯体の表面に活物質を塗布して構成され、巻き取り電極体（４）が発生する電力を一対の電極端子部から外部へ取り出すことが出来る非水電解液二次電池において、前記一対の電極端子部はそれぞれ、電池缶（１）と同軸上に電池缶（１）を貫通して取り付けられた金属製の電極端子(91)によって構成され、巻き取り電極体（４）の軸方向の少なくとも一方の端部には、正極(41)或いは負極(43)を構成する芯体に活物質の塗布されていない非塗工部が突出し、該突出部には集電機構が連結され、これによって該突出部が巻き取り電極体（４）の中心軸と同軸上に並ぶ複数のリング状領域(4a)(4b)(4c)に分けられており、該集電機構は、最内周のリング状領域の内周面に嵌入する金属製の丸軸部材(97)と、丸軸部材(97)の１本の半径線上に配設されて、隣接するリング状領域の間にそれぞれ介在する１或いは複数枚の金属製のスペーサ片（５）と、前記１本の半径線上に設置されて、最外周のリング状領域の外周面に接合された金属製の押圧片(51)と、押圧片(51)を丸軸部(97)に向かって押圧するための金属製のねじ機構とを具え、前記丸軸部材(97)及びねじ機構がそれぞれ、電池缶（１）内に突出する電極端子(91)の端部に連結されていることを特徴とする非水電解液二次電池。

【請求項２】　前記丸軸部材(97)は、電池缶（１）内に突出する電極端子(91)の端部に一体に設けられ、前記ねじ機構は、電池缶（１）内に突出する電極端子(91)の端部に突設されたアーム（６）と、該アーム（６）の先端部に係合するねじ軸(52)とによって構成され、該ねじ軸(52)の先端部に前記押圧片(51)が取り付けられている請求項１に記載の非水電解液二次電池。

【請求項３】　前記巻き取り電極体（４）の各リング状領域(4a)(4b)(4c)は、それらの領域を展開したときの長さが略同一となる様に分けられている請求項１又は請求項２に記載の非水電解液二次電池。

【請求項４】　スペーサ片（５）及び押圧片(51)はそれぞれ、丸軸部材(97)と同心の円弧線に沿う形状に形成されている請求項１乃至請求項３の何れかに記載の非水電解液二次電池。

【発明の詳細な説明】

【０００１】

【発明の属する技術分野】本発明は、電池缶の内部に二次電池要素となる巻き取り電極体が収容されて、電極缶に設けた一対の電極端子部から巻き取り電極体の発生電力を取り出すことが出来る非水電解液二次電池に関するものである。

【０００２】

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【従来の技術】近年、携帯型電子機器、電気自動車等の電源として、エネルギー密度の高いリチウムイオン二次電池が注目されている。例えば電気自動車に用いられる比較的大きな容量の円筒型リチウムイオン二次電池は、図４及び図５に示す様に、筒体(11)の両端部に蓋体(12)(12)を溶接固定してなる円筒状の電池缶（１）の内部に、巻き取り電極体（２）を収容して構成されている。両蓋体(12)(12)には、正負一対の電極端子機構（９）（９）が取り付けられており、巻き取り電極体（２）の両極と両電極端子機構（９）（９）とが、それぞれ複数本の電極タブ（３）により互いに接続されて、巻き取り電極体（２）が発生する電力を一対の電極端子機構（９）（９）から外部に取り出すことが可能となっている。又、各蓋体(12)には圧力開閉式のガス排出弁(13)が取り付けられている。

【０００３】巻き取り電極体（２）は、図６に示す様に、それぞれ帯状の正極(21)と負極(23)の間に帯状のセパレータ(22)を介在させて、これらを渦巻き状に巻回して構成されている。正極(21)は、アルミニウム箔からなる帯状芯体の両面にリチウム複合酸化物からなる正極活物質(24)を塗布して構成され、負極(23)は、銅箔からなる帯状芯体の両面に炭素材料を含む負極活物質(25)を塗布して構成されている。セパレータ(22)には、非水電解液が含浸されている。正極(21)及び負極(23)には夫々、複数本の電極タブ（３）の基端部がスポット溶接等によって接合され、先端部は巻き取り電極体（２）から突出している。尚、正極(21)に接合された電極タブ（３）はアルミニウム箔から形成され、負極(23)に接合された電極タブ（３）は銅箔から形成されている。

【０００４】そして、図５に示す如く、極性が同じ複数本の電極タブ（３）の先端部(31)が１つの電極端子機構（９）に接続されている。尚、図５においては、便宜上、一部の電極タブの先端部が電極端子機構（９）に接続されている状態のみを示し、他の電極タブについては、先端部が電極端子機構（９）に接続されている状態の図示を省略している。

【０００５】電極端子機構（９）は、電池缶（１）の蓋体(12)を貫通して取り付けられた電極端子(91)を具え、該電極端子(91)の基端部には鍔部(92)が形成されている。蓋体(12)の貫通孔には絶縁パッキング(93)が装着され、蓋体(12)と締結部材(91)の間の電気的絶縁性とシール性が保たれている。電極端子(91)には、蓋体(12)の外側からワッシャ(94)が嵌められると共に、第１ナット(95)及び第２ナット(96)が螺合している。そして、第１ナット(95)を締め付けて、電極端子(91)の鍔部(92)とワッシャ(94)によって絶縁パッキング(93)を挟圧することにより、シール性を高めている。前記複数本の電極タブ（３）の先端部(31)は、電極端子(91)の鍔部(92)に、スポット溶接或いは超音波溶接によって固定されている。

【０００６】ところで、リチウムイオン二次電池においては、電池の大型化に伴って、正極及び負極の長さが大

きくなるため、上述の如き電極タブによる集電構造では集電性が低く、内部抵抗にばらつきが発生したり、放電容量が低下するなどの問題が生じる。

【０００７】そこで、正極及び負極の全長に亘って均一な集電性を得るべく、図７に示す如き集電構造が提案されている。該集電構造において、巻き取り電極体（４）は同様に、芯体(45)の表面に正極活物質(44)を塗布してなる正極(41)と、芯体(47)の表面に負極活物質(46)を塗布してなる負極(43)と、非水電解液が含浸されたセパレータ(42)とから構成されるが、正極(41)及び負極(43)はそれぞれセパレータ(42)上に幅方向へずらして重ね合わされ、渦巻き状に巻き取られている。これによって、巻き取り電極体（４）の巻き軸方向の両端部の内、一方の端部では、セパレータ(42)の端縁よりも外方へ正極(41)の芯体(45)の端縁(48)が突出すると共に、他方の端部では、セパレータ(42)の端縁よりも外方へ負極(43)の芯体(47)の端縁(48)が突出している。そして、巻き取り電極体（４）の両端部にはそれぞれ円板状の集電板(32)が抵抗溶接され、該集電板(32)がリード部材(33)を介して前記電極端子機構（９）に接続される。

【０００８】しかしながら、図７に示す集電構造を有する非水電解液二次電池においては、巻き取り電極体（４）の正極(41)及び負極(43)を構成する芯体(45)(47)の端縁(48)(48)の面積が小さいため、芯体端縁と集電板(32)の間の接触面積が小さく、これによって電池の内部抵抗が大きくなる問題があった。又、高出力を得るためには、出来るだけ内部抵抗を低減させることが必要であり、更に、製造コスト削減のためには、生産性に優れた集電構造が必要となる。

【０００９】そこで、図８に示す様に、平板状本体(63)に複数の折曲部(64)を形成した集電板(62)を用い、該集電板(62)を巻き取り電極体（４）の芯体端縁(48)に押し付けた状態で、該折曲部(64)を芯体端縁(48)に抵抗溶接する集電構造が提案されている（例えば特開平１１－３１４９７号参照）。

【００１０】又、円板状の集電板に代えて、図９に示す如く複数のスリット(66)が凹設された集電部材(65)を巻き取り電極体（４）の端部に設置し、該集電部材(65)のスリット(66)へ芯体端縁(48)を嵌入せしめた状態で、集電部材(65)の表面にレーザビームを照射して、レーザ溶接を施す集電構造が提案されている（例えば特開平１０－２６１４４１号参照）。

【００１１】

【発明が解決しようとする課題】ところが、図８の如く折曲部を形成した集電板を抵抗溶接する集電構造においては、リチウムイオン二次電池の如く芯体の厚さが極めて小さい場合、溶接が困難であるばかりでなく、溶接部における電気抵抗が大きく、依然として集電性能が低い問題があった。

【００１２】又、図９の如く複数のスリットが凹設された集電部材を芯体端縁にレーザ溶接する集電構造では、複雑な形状を有する集電部材が必要となるばかりでなく、集電部材に対する溶接作業が必要であるために生産性に劣る問題があった。

【００１３】本発明の目的は、従来よりも内部抵抗が低く、然も生産性に優れた集電構造を有する非水電解液二次電池を提供することである。

【００１４】

【課題を解決する為の手段】本発明に係る非水電解液二次電池は、電池缶（１）の内部に巻き取り電極体（４）を収納して構成される。巻き取り電極体（４）は、それぞれ帯状の正極(41)と負極(43)の間に非水電解液を含むセパレータ(42)を介在させてこれらを渦巻き状に巻き取ったものであり、正極(41)及び負極(43)はそれぞれ、帯状芯体の表面に活物質を塗布して構成される。巻き取り電極体（４）が発生する電力は、一対の電極端子部から外部へ取り出すことが出来る。ここで、前記一対の電極端子部はそれぞれ、電池缶（１）と同軸上に電池缶（１）を貫通して取り付けられた金属製の電極端子(91)によって構成されている。又、巻き取り電極体（４）の軸方向の少なくとも一方の端部には、正極(41)或いは負極(43)を構成する芯体に活物質の塗布されていない非塗工部が突出し、該突出部には集電機構が連結され、これによって該突出部が巻き取り電極体（４）の中心軸と同軸上に並ぶ複数のリング状領域(4a)(4b)(4c)に分けられている。前記集電機構は、最内周のリング状領域の内周面に嵌入する金属製の丸軸部材(97)と、丸軸部材(97)の１本の半径線上に配設されて、隣接するリング状領域の間にそれぞれ介在する１或いは複数枚の金属製のスペーサ片（５）と、前記１本の半径線上に設置されて、最外周のリング状領域の外周面に接合された金属製の押圧片(51)と、押圧片(51)を丸軸部(97)に向かって押圧するための金属製のねじ機構とを具え、前記丸軸部材(97)及びねじ機構がそれぞれ、電池缶（１）内に突出する電極端子(91)の端部に連結されている。

【００１５】上記本発明のリチウムイオン二次電池においては、ねじ機構を締め付けることによって、押圧片(51)が丸軸部材(97)に向かって駆動される。この結果、最内周のリング状領域は、丸軸部材(97)とスペーサ片（５）によって強く挟圧されて、芯体非塗工面どうしが密着した非塗工芯体束(49)に束ねられる。又、最外周のリング状領域は、押圧片(51)とスペーサ片（５）によって強く挟圧されて、芯体非塗工面どうしが密着した非塗工芯体束(49)に束ねられる。更に、中間のリング状領域は２枚のスペーサ片（５）（５）によって強く挟圧されて、芯体非塗工面どうしが密着した非塗工芯体束(49)に束ねられる。この様にして、巻き取り電極体（４）の各非塗工芯体束(49)と、集電機構の各構成部材、即ち丸軸部材(97)、スペーサ片（５）及び押圧片(51)とが、互いに広い接触面積で圧着するので、接触面における電気抵抗は極めて小さく

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なる。

【００１６】尚、スペーサ片（５）は、丸軸部材(97)及び押圧片(51)から独立しており、丸軸部材(97)と押圧片(51)の間で自由に移動可能であるため、各非塗工芯体束(49)に均等な挟圧力を与えることが出来る。又、巻き取り電極体（４）の芯体非塗工部は、スペーサ片（５）の介在によって、局所的に大きな変形を生じることはなく、この結果、活物質塗布層の剥離を防止することが出来る。

【００１７】巻き取り電極体（４）が発生する電流は、前記集電機構によって集電された後、丸軸部材(97)から電極端子(91)へ流れるルートと、押圧片(51)及びねじ機構から電極端子(91)へ流れるルートを経て、外部へ取り出される。ここで、巻き取り電極体（４）と集電機構の間の電気抵抗は小さいので、高い出力密度が得られる。又、上述の２つの電流取り出しルートが形成されるので、大電流での出力が可能である。

【００１８】具体的には、前記巻き取り電極体（４）の各リング状領域(4a)(4b)(4c)は、それらの領域を展開したときの長さが略同一となる様に分割されている。該具体的構成によれば、集電機構によって、巻き取り電極体（４）から均一に集電が行なわれるので、高い集電性能が得られる。

【００１９】更に具体的な構成において、スペーサ片（５）及び押圧片(51)はそれぞれ、丸軸部材(97)と同心の円弧線に沿う形状に形成されている。これによって、スペーサ片（５）及びスペーサ片（５）と非塗工芯体束(49)との間の密着面積が大きくなり、更に電気抵抗が小さくなる。

【００２０】尚、正極側の集電機構の各構成部材（丸軸部材(97)、スペーサ片（５）、押圧片(51)、ねじ機構）は、アルミニウム、ステンレス鋼、ニッケル等を用いて作製することが出来る。又、負極側の集電機構の各構成部材は、銅、ステンレス鋼、ニッケル等を用いて作製することが出来る。巻き取り電極体（４）を構成する正極活物質としては、金属酸化物である$LiCoO_2$、$LiNiO_2$、$LiCo_{1-x}Ni_xO_2$、$LiMn_2O_4$及びこれらの複合化合物からなる群から選択される、少なくとも一種の材料を用いることが出来る。負極活物質としては、黒鉛、コークス等の炭素材料、リチウム金属、リチウム合金、$Li_xFe_2O_3$、Li_xWO_2等の金属酸化物材料や、ポリアセチレン等の導電性高分子材料を用いることが出来る。電解質としては、リチウムイオンなどの金属イオンを含む$LiPF_6$、$LiClO_4$、$LiCF_3SO_3$等が挙げられる。また、電解質の有機溶媒には、エチレンカーボネート、ジエチルカーボネート、ジメトキシメタン、スルホラン等を単独或いは混合して用いることが出来る。電解液としては、これら溶媒に前記電解質を０．７～１．５M(mol／l)程度の割合で溶解した溶液が挙げられる。

【００２１】

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【発明の効果】本発明に係る非水電解液二次電池において、集電機構を構成するスペーサ片（５）及び押圧片(51)は、例えば金属板をプレス加工することによって、容易に作製することが出来、ねじ機構は、ねじ軸を用いて容易に作製することが出来る。又、集電機構の取付けは、ねじ込み作業だけで行なうことが出来、溶接等は不要であるため、取付け工程は簡易であり、これによって、従来よりも高い生産性が実現される。然も、巻き取り電極体と集電機構の間の電気抵抗を小さく抑えることが出来るので、集電効率が改善されて、従来よりも高い出力密度が得られる。

【００２２】

【発明の実施の形態】以下、本発明を円筒型リチウムイオン二次電池に実施した形態につき、図面に沿って具体的に説明する。本発明に係る円筒型リチウムイオン二次電池は、図４及び図１に示す如く、筒体(11)の両端部に蓋体(12)(12)を溶接固定してなる円筒状の電池缶（１）の内部に、巻き取り電極体（４）を収容して構成されている。両蓋体(12)(12)には、正負一対の電極端子機構（９）（９）が取り付けられており、巻き取り電極体（４）の両極と両電極端子機構（９）（９）とが、それぞれ後述する集電構造により互いに接続されて、巻き取り電極体（４）が発生する電力を一対の電極端子機構（９）（９）から外部に取り出すことが可能となっている。又、各蓋体(12)には圧力開閉式のガス排出弁(13)が取り付けられている。

【００２３】巻き取り電極体（４）は、図２に示す様に、それぞれ帯状の正極(41)と負極(43)の間に帯状のセパレータ(42)を介在させて、これらを渦巻き状に巻回して構成されている。正極(41)は、アルミニウム箔からなる帯状芯体(45)の両面にリチウム複合酸化物からなる正極活物質(44)を塗布して構成され、負極(43)は、銅箔からなる帯状芯体(47)の両面に炭素材料を含む負極活物質(46)を塗布して構成されている。セパレータ(42)には、非水電解液が含浸されている。又、正極(41)の一方の端部には、正極活物質(44)の塗布されていない芯体非塗工部が形成され、負極(43)の他方の端部には、負極活物質(46)の塗布されていない芯体非塗工部が形成されている。

【００２４】巻き取り電極体（４）の作製において、正極(41)及び負極(43)はそれぞれセパレータ(42)上に幅方向へずらして重ね合わされ、渦巻き状に巻き取られている。これによって、巻き取り電極体（４）の巻き軸方向の両端部の内、一方の端部では、セパレータ(42)の端縁よりも外方へ正極(41)の芯体非塗工部の端縁(48)が突出すると共に、他方の端部では、セパレータ(42)の端縁よりも外方へ負極(43)の芯体非塗工部の端縁(48)が突出している。

【００２５】巻き取り電極体（４）の正極側及び負極側の端部にはそれぞれ、図３に示す集電機構が取り付けられ、該集電機構が図１に示す電極端子機構（９）に連結されている。電極端子機構（９）は、電池缶（１）の蓋体(12)

を貫通して取り付けられた電極端子(91)を具え、該電極端子(91)の基端部には鍔部(90)が形成されている。蓋体(12)の貫通孔には絶縁パッキング(93)が装着され、蓋体(12)と締結部材(91)の間の電気的絶縁性とシール性が保たれている。電極端子(91)には、蓋体(12)の外側からワッシャ(94)が嵌められると共に、第１ナット(95)及び第２ナット(96)が螺合している。そして、第１ナット(95)を締め付けて、電極端子(91)の鍔部(92)とワッシャ(94)によって絶縁パッキング(93)を挟圧することにより、シール性を高めている。

【００２６】電極端子(91)の下端部には、図３に示す如く鍔部(90)に、円筒状の丸軸部材(97)が突設されている。又、鍔部(90)の外周面には、左右一対のアーム(６)(６)が突設され、各アーム(６)の先端部には、垂直板部(61)が下向きに突設されている。そして、各垂直板部(61)にねじ軸(52)が螺合し、該ねじ軸(52)の先端部には、丸軸部材(97)の外周面に対向して、押圧片(51)が取り付けられている。更に、両押圧片(51)と丸軸部材(97)の間にはそれぞれ、２枚のスペーサ片(５)(５)が配置されている。ここで、スペーサ片(５)及び押圧片(51)は、丸軸部材(97)と同心の円弧線に沿う円弧状に形成されている。

【００２７】尚、正極側の丸軸部材(97)、アーム(６)、ねじ軸(52)、押圧片(51)及びスペーサ片(５)はそれぞれアルミニウム製であり、負極側の丸軸部材(97)、アーム(６)、ねじ軸(52)、押圧片(51)及びスペーサ片(５)はそれぞれ銅製である。

【００２８】図１に示す如く、巻き取り電極体(４)の各端部に突出する芯体非塗工部は、巻き取り電極体(４)の半径方向に並ぶ３つのリング状領域(4a)(4b)(4c)に分けられて、最内周のリング状領域(4c)の内周面には丸軸部材(97)が嵌入し、最外周のリング状領域(4a)の外周面には、１８０度の角度差で一対の押圧片(51)(51)が接合されている。又、最内周のリング状領域(4c)と中間のリング状領域(4b)の間、並びに最外周のリング状領域(4a)と中間のリング状領域(4b)の間にはそれぞれ、１８０度の角度差で２枚のスペーサ片(５)(５)が介在している。これによって、巻き取り電極体(４)の直径線上に並ぶ６つの非塗工芯体束(49)～(49)が形成されている。尚、巻き取り電極体(４)の３つのリング状領域(4a)(4b)(4c)は、これらの領域を展開したときの長さ、即ち活物質塗布層の面積が略同一となる様に分けられている。

【００２９】図３に示す集電機構の取付けにおいては、先ず、巻き取り電極体(４)の端部に４枚のスペーサ片(５)～(５)を挿入すると共に、巻き取り電極体(４)の中央孔へ丸軸部材(97)を嵌入せしめた後、両ねじ軸(52)(52)を締め付ける。これによって、各押圧片(51)が丸軸部材(97)に向かって駆動される。この結果、図１に示す最内周のリング状領域(4c)は、丸軸部材(97)とスペーサ片(５)によって強く挟圧されて、芯体非塗工面どうしが密着した非塗工芯体束(49)に束ねられる。又、最外周のリング状領域(4a)は、押圧片(51)とスペーサ片(５)によって強く挟圧されて、芯体非塗工面どうしが密着した非塗工芯体束(49)に束ねられる。更に、中間のリング状領域(4b)は２枚のスペーサ片(５)(５)によって強く挟圧されて、芯体非塗工面どうしが密着した非塗工芯体束(49)に束ねられる。

【００３０】この様にして、巻き取り電極体(４)の各非塗工芯体束(49)の両面に、集電機構の各構成部材、即ち丸軸部材(97)、スペーサ片(５)及び押圧片(51)が圧着されて、集電機構の固定が行なわれる。該集電構造においては、巻き取り電極体(４)と集電機構とが広い接触面積で互いに圧着するので、接触面での電気抵抗は極めて小さなものとなる。

【００３１】上記円筒型リチウムイオン二次電池において、巻き取り電極体(４)が発生する電流は、丸軸部材(97)を経て電極端子(91)へ至るルートと、押圧片(51)、ねじ軸(52)及びアーム(６)を経て電極端子(91)へ至るルートを流れて、外部へ取り出される。ここで、巻き取り電極体(４)と集電機構の間の電気抵抗は小さいので、高い出力密度が得られる。又、上述の２つの電流取り出しルートが形成されるので、大電流での出力が可能である。更に、集電機構を構成するスペーサ片(５)、押圧片(51)及びアーム(６)は、例えば金属板をプレス加工することによって、容易に作製することが出来、集電機構の取付けは、ねじ軸(52)をねじ込みだけで行なうことが出来るので、従来よりも高い生産性が実現される。

【００３２】

【実施例】次の様にして、図１に示す実施例電池Ａと図５に示す比較例電池Ｂとを作製し、性能を比較した。

【００３３】実施例電池Ａの作製

(正極の作製)正極活物質としてのＬｉＮｉ$_{0.7}$Ｃｏ$_{0.3}$Ｏ$_2$は、リチウムの水酸化物とニッケルの水酸化物とコバルトの水酸化物とを混合し、８００℃の空気中で２４時間の焼成を施すことにより得た。この正極活物質と導電剤としての炭素を重量比９０：５の割合で混合し、正極合剤を得た。次に、結着剤であるポリフッ化ビニリデンをＮ－メチルー２－ピロリドン(ＮＭＰ)に溶解させて、ＮＭＰ溶液を調製した。そして、正極合剤とポリフッ化ビニリデンの重量比が９５：５になるように正極合剤とＮＭＰ溶液を混練して、スラリーを調製した。このスラリーを、正極芯体としてのアルミニウム箔の両面にドクターブレード法により塗布し、１５０℃で２時間の真空乾燥を施して、正極を得た。尚、正極芯体には、芯体端縁からの幅が２０mmの非塗工部を形成した。

【００３４】(負極の作製)炭素塊(ｄ００２＝３．３５６Å；Ｌｃ＞１０００Å)に空気流を噴射して粉砕し、これをふるいにかけて、平均粒子径１８μmの黒鉛粉末を得た。次に、コークス塊に空気流を噴射して粉砕し、こ

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れをふるいにかけて、平均粒子径１８μmのコークス粉末を得た。又、結着剤であるポリフッ化ビニリデンをＮＭＰに溶解させて、ＮＭＰ溶液を調製した。そして、黒鉛粉末とコークス粉末とポリフッ化ビニリデンの重量比が７２：１８：１０になる様に黒鉛粉末とコークス粉末とＮＭＰ溶液とを混練して、スラリーを調製した。このスラリーを、負極芯体としての銅箔の両面にドクターブレード法により塗布し、１５０℃で２時間の真空乾燥を施して、負極を得た。尚、負極芯体には、芯体端縁からの幅が２０mmの非塗工部を形成した。

【００３５】(電池の組立)以上の工程によって得られた正極及び負極と、イオン透過性のポリエチレン製微多孔膜からなるセパレータとを用いて、図２に示す巻き取り電極体(４)を作製した。そして、巻き取り電極体(４)の両端部にそれぞれ、図１に示す本発明の集電機構と、電極端子機構(９)を構成する電極端子(91)とを取り付けた後、ねじ軸(52)(52)を締め付けた。次に、該巻き取り電極体(４)を筒体(11)の内部に収容し、該筒体(11)の各開口部に蓋体(12)を溶接固定した。最後に電極端子(91)にナット(95)(96)を螺合せしめて、実施例電池Ａを組み立てた。

【００３６】比較例電池Ｂの作製

正極及び負極の作製工程で、非塗工部を設けることなく、芯体にスラリーを全面塗布したこと以外は実施例電池Ａと同様にして、正極及び負極を作製した。

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(電池の組立)図６に示す様に、正極を構成しているアルミニウム箔の表面に１５本のアルミニウム製電極タブを２０ｃｍ間隔で溶接すると共に、負極を構成している銅箔の表面に１５本の銅製電極タブを２０ｃｍ間隔で溶接した。そして、正極と負極の間にイオン透過性のポリエチレン製微多孔膜からなるセパレータを挟んで、これらを渦巻き状に巻回し、巻き取り電極体(２)を作製した。尚、正極及び負極の電極タブの厚さは０．１mmとした。そして、図５に示す如く、各電極の電極タブ(３)を電極端子機構(９)の鍔部(92)に溶接して、比較例電池Ｂを組み立てた。尚、実施例電池Ａと比較例電池Ｂの各電極の活物質塗布量は同量とした。

【００３７】(性能比較実験)実施例電池Ａ及び比較例電池Ｂについて、巻き取り電極体を筒体に収容する前に、１ｋＨｚにおける交流インピーダンスを測定したところ、下記表１に示す結果が得られた。尚、交流インピーダンスの測定は、正極側、負極側ともに、巻き取り電極体の最外周部に位置する芯体非塗工部と電極端子との間で行なった。

【００３８】

【表１】

	負極側インピーダンス	正極側インピーダンス
実施例電池Ａ	4.5mΩ	8.5mΩ
比較例電池Ｂ	25.5mΩ	10.8mΩ

【００３９】表１から明らかな様に、正極側、負極側の何れにおいても、実施例電池Ａのインピーダンスは、比較例電池Ｂのインピーダンスよりも小さくなっており、このことから、本発明の円筒型リチウムイオン二次電池によれば、従来の電池よりも高い出力密度を得ることが出来ると言える。

【図面の簡単な説明】

【図１】本発明に係る円筒型リチウムイオン二次電池に採用されている集電機構の断面構成及び平面構成を示す図である。

【図２】該二次電池に装備されている巻き取り電極体の一部展開斜視図である。

【図３】本発明の集電機構の分解斜視図である。

【図４】円筒型リチウムイオン二次電池の外観を示す斜視図である。

【図５】従来の円筒型リチウムイオン二次電池に採用されている集電構造を表わす断面図である。

【図６】該二次電池に装備されている巻き取り電極体の一部展開斜視図である。

【図７】従来の他の集電構造を具えた巻き取り電極体の一部展開斜視図である。

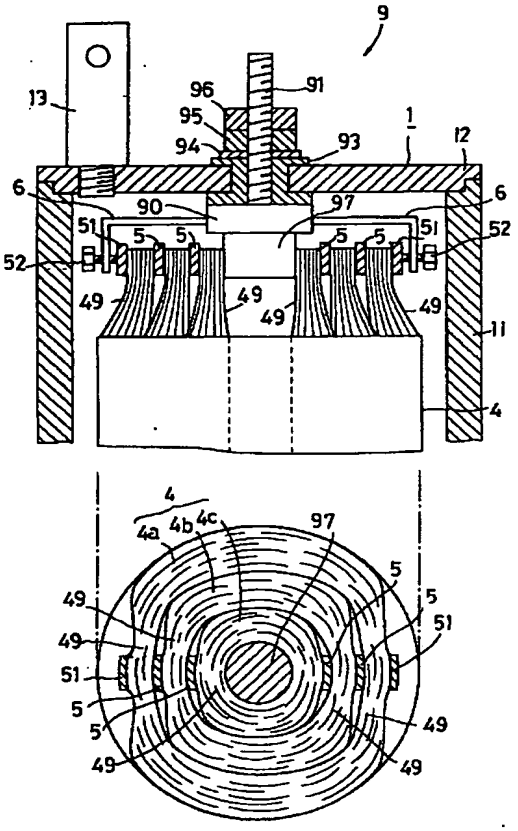
【図８】従来の更に他の集電構造を表わす斜視図である。

【図９】従来の更に他の集電構造を表わす斜視図である。

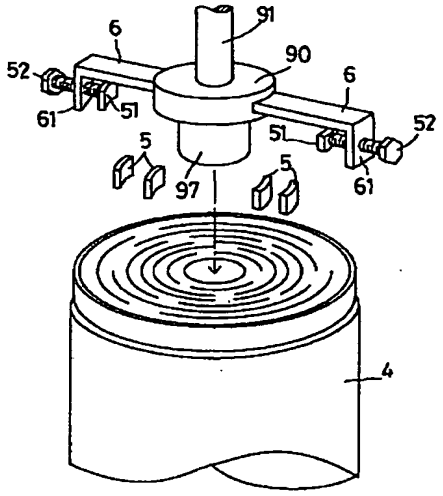
【符号の説明】

(１)　電池缶
(11)　筒体
(12)　蓋体
(４)　巻き取り電極体
(49)　非塗工芯体束
(９)　電極端子機構
(97)　丸軸部材
(５)　スペーサ片
(51)　押圧片
(52)　ねじ軸
(６)　アーム

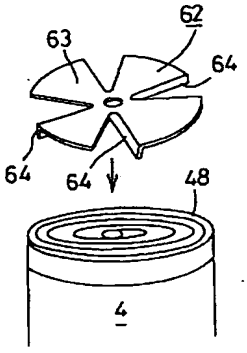
【図1】



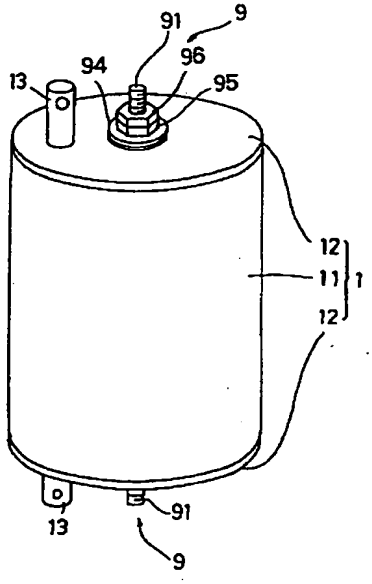
【図3】



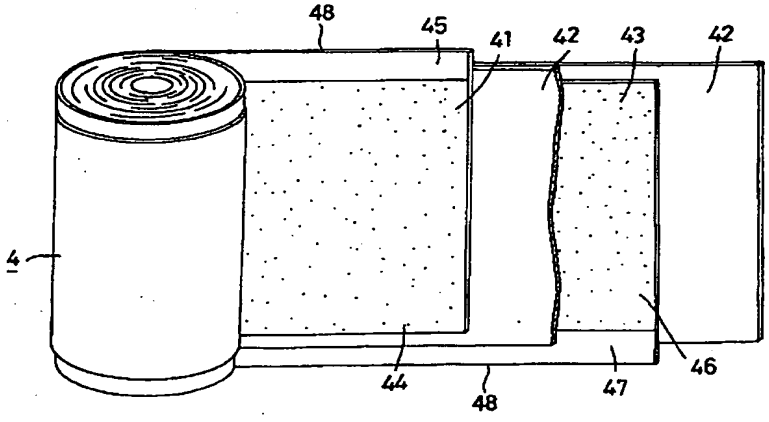
【図8】



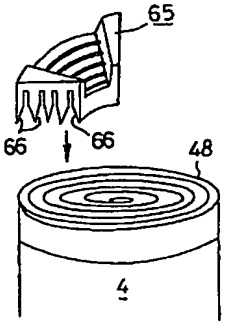
【図4】



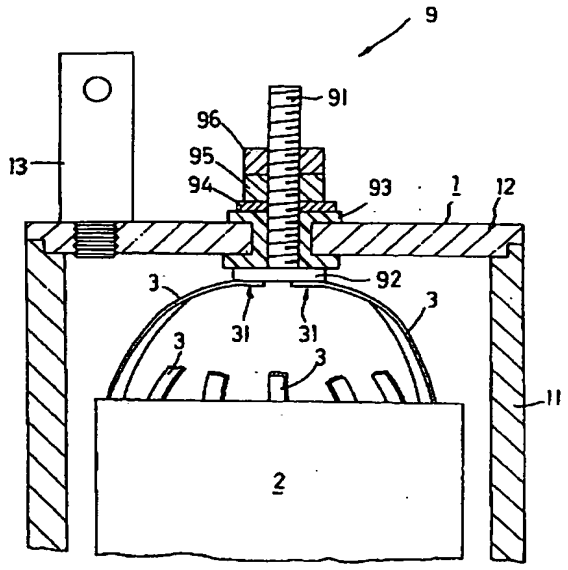
【図2】



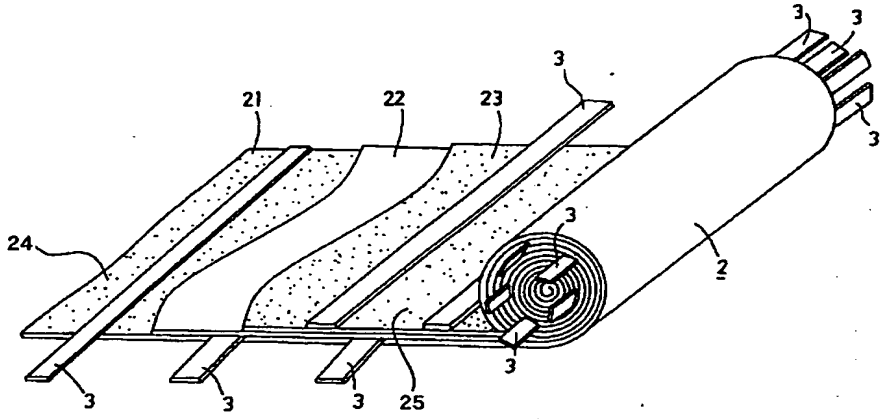
【図9】



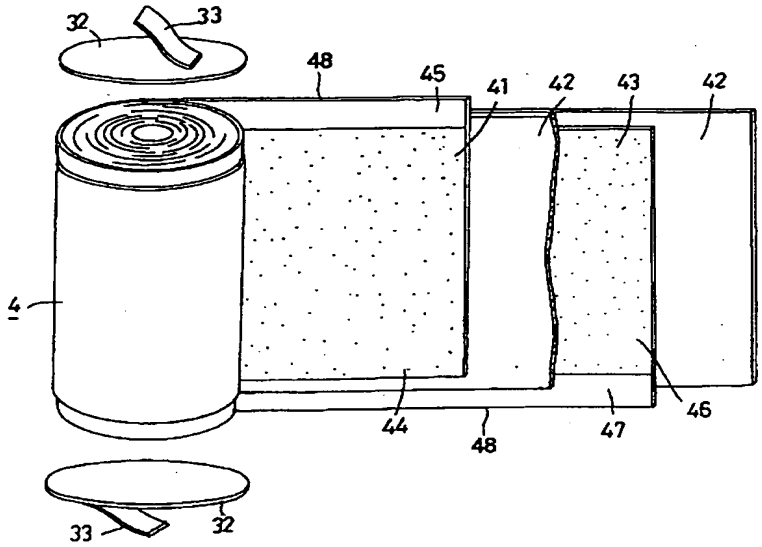
【図5】



【図6】



【図7】



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